



**Center for Energy and Environmental Policy Research**

**1996 Update on Compliance and Emissions Trading under the  
U.S. Acid Rain Program**

by

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**1996 UPDATE**

**ON COMPLIANCE AND EMISSIONS TRADING**

**UNDER THE U.S. ACID RAIN PROGRAM**

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## I. INTRODUCTION

This paper reports on the second year of compliance with the sulfur dioxide (SO<sub>2</sub>) emissions-reduction and -trading provisions of Title IV of the 1990 Clean Air Act Amendments (CAAA). The material is intended as a supplement to Ellerman, *et al.* (1997), which evaluated the emissions-trading program in 1995, and to which the reader is referred for background and definitions of terms. In the main, compliance with Title IV in 1996 was very similar to that which occurred in 1995. Sulfur dioxide emissions from affected units were about 4.0 million tons lower than they would have been in the absence of the emissions restrictions specified in Title IV. As in 1995, about half of the emissions reduction could be attributed to the use of scrubbers and the other half to switching. Finally, at 5.43 million tons, 1996 emissions from these units were significantly below the 1996 "cap" of 8.12 million tons, not to mention the 3.25 million allowances banked from 1995 that could have been used in 1996. However, the more interesting aspect of compliance with Title IV in 1996 lies not so much in the aggregate results as in the small changes on the margin that indicate how affected parties were using the flexibility afforded by emissions trading. In this regard, the most significant change was a 6% *increase* in emissions from affected units. With the decreasing number of allowances issued annually as Phase II approaches and a fixed Phase II "cap," one would have expected emissions to be lower in 1996 than in 1995, not higher. The unexpected increase in average emission rates is, however, the mirror image of the equally unexpected fall in the price of allowances between 1994 and 1995. With lower allowance prices, it is cheaper in at least some locations to spend more on allowances in order to take advantage of lower-priced, higher-sulfur coal.

## II. AGGREGATE COMPLIANCE DATA FOR 1995 AND 1996

### A. *All Affected Units*

The summary compliance statistics for the first two years of Title IV are presented in Table 1 for both mandatorily (Table A) and voluntarily (substitution, compensation, and opt-in industrial) affected units subject to emissions limits in Phase

I. In comparing 1996 with 1995, the key points are:

<b>Table 1. Summary: Title IV Compliance Data</b>			
<b>1995 DATA</b>	<b>Table A</b>	<b>Voluntary</b>	<b>Total</b>
Number of units	263	182	445
Generating capacity (GW <sup>e</sup> )	88.0	41.6	129.6
1985–87 baseline emissions <sup>a</sup> (10 <sup>12</sup> Btu)	9,257	1,389	10,646
Counterfactual emissions <sup>b</sup> (10 <sup>3</sup> )	8,171	1,066	9,237
Actual emissions (10 <sup>3</sup> )	4,445	853	5,298
Allowances issued (10 <sup>3</sup> )	7,215	1,329	8,544
Allowances banked(10 <sup>3</sup> )	2,770	476	3,246
Title IV emission reduction <sup>c</sup> (10 <sup>3</sup> )	3,726	213	3,939
<b>1996 DATA</b>	<b>Table A</b>	<b>Voluntary</b>	<b>Total</b>
Number of units	263	168	431
Generating capacity (GW <sup>e</sup> )	88.0	37.2	125.2
1985–87 baseline emissions <sup>a</sup> (10 <sup>12</sup> Btu)	9,257	1,261	10,518
Counterfactual emissions <sup>b</sup> (10 <sup>3</sup> )	8,606	869	9,475
Actual emissions (10 <sup>3</sup> )	4,759	674	5,433
Allowances (10 <sup>3</sup> )	6,888	1,234	8,122
Banked allowances (10 <sup>3</sup> )	2,129	560	2,689
Title IV emission reduction <sup>c</sup> (10 <sup>3</sup> )	3,847	195	4,042

**Notes:** a. Sum of baseline heat input (average 1985–87) times 1985 emission rate for all affected units.  
b. Sum of 1993 emission rate times heat input during the year for all affected units.  
c. Counterfactual emissions less actual emissions.

- Fewer units and generating capacity were affected.
- Fewer allowances were issued.
- Emissions from affected units increased by 135,000 tons.
- The number of allowances banked decreased by 557,000.
- The emissions reduction attributable to Title IV remained at about 4.0 million tons annually.

Electric utility operators can decide from year to year whether non-Table A units will become or remain affected units under Phase I.<sup>2</sup> In 1996, the number of units and generating capacity affected by Title IV decreased—the number of voluntarily affected units by 14, due to the departure of 26 substitution units and six compensation units and the accession of 11 substitution units and seven industrial opt-in units.

Sulfur dioxide emissions increased by 135,000 tons in 1996 because of two compensating factors. Table A units increased emissions by 314,000 tons due to greater heat input and a slightly higher average emission rate; however, emissions from the smaller number of voluntarily affected units were 179,000 tons less than in 1995.

The principal reason for the issuance of fewer allowances in 1996 was the discontinuation of approximately 314,000 early reduction credits issued to five Table A units for 1995 only. The smaller number of voluntarily affected units also accounted for a net reduction of 117,000 allowances. In addition, there were minor adjustments in the number of Phase I extension and substitution/compensation allowances issued to units affected in both years.

As in 1995, 1996 emissions were well below the total number of allowances issued for the year, but the amount banked by individual units in 1996 was 557,000, or almost 20% less than in 1995. At the end of 1996, the total bank of allowances from 1995 and 1996, including the 150,000 allowances sold at auction for each vintage, amounted to approximately 6.24 million allowances.

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<sup>2</sup> Title IV of the 1990 CAAA lists in Table A the 263 units that are mandated to become subject to Title IV restrictions in Phase I, beginning in 1995. The legislation also provides that 1) other utility units not subject to Title IV until Phase II can, beginning in the year 2000, elect to become affected units in Phase I as substitution or compensation units, and 2) industrial process units not otherwise affected may similarly opt-in during Phase I or II.

Despite the increase in emissions, we estimate that emissions *reductions* attributable to Title IV remained about the same in 1996 as in 1995—at about 4 million tons—because counterfactual emissions (what we estimate emissions would have been without Title IV) increased by 238,000 tons due to greater generation of electricity at Table A units. This increase is approximately 100,000 tons more than the actual increase in emissions at affected units; hence, the slight increase in the estimated reduction attributable to Title IV, from 3.94 million tons to 4.04 million tons. It must be emphasized, however, that the figure for counterfactual emissions is only an *estimate* based upon assumptions about the demand for electricity and unit emission rates in the absence of Title IV. As in 1995, Table A units accounted for almost all Title IV emissions reductions.

### ***B. Units Entering and Exiting the Title IV Program***

The changing composition of units between 1995 and 1996 complicates the analysis of compliance behavior unless the analysis is restricted to the units that were subject to Phase I restrictions in both years. Table 2 provides more detail about the voluntarily affected units in 1995 and 1996 by category and isolates the 150 voluntarily affected units that were subject to Title IV in both years.

Taken as a whole, the 32 substitution/compensation units exiting the program in 1996 had 1995 emissions 15,000 tons higher in the aggregate than the number of allowances issued to them, while the 18 new voluntarily affected units banked a total of 32,000 allowances in 1996. At the unit level, 16 of the 32 exiting units were short of allowances in 1995, and they had to acquire additional allowances by transfer from other units or by purchase. In contrast, only two of the 18 newly volunteering units were short of allowances in 1996.

Since voluntarily affected units can exit or enter voluntarily by declaration made one month before the close of the calendar year, it would be unusual for a unit that had such an option to be caught short, and in fact most are not. Still, unexpected changes in the dispatch of units in the last month of the year can lead to the observed result. In addition, as noted by Montero (1997) in an earlier study of voluntary compliance in

1995, the reasons for volunteering are several and complex. In this regard, it is worth noting that not all of the units that were short of allowances in 1995 exited the program in 1996, although the majority of them did. Eleven units that were short of allowances in 1995 stayed, and 9 of these units were also short of allowances in 1996. In addition, another 8 voluntarily affected units that had banked allowances in 1995 increased emissions in 1996 such that they were short of allowances in 1996. Nevertheless, the total number of such units decreased from 27 in 1995 to 18 in 1996.

In addition to the electric utility generating units that can qualify as substitution or compensation units, there were seven units at two industrial plants, in Tennessee and in Indiana, that opted into the program in 1996. (There were no such units in 1995.) As discussed in more detail by Atkeson (1997), the plant in Tennessee was shut down when an arrangement was made to obtain substitute steam from four generating units operated by the Tennessee Valley Authority. The three units at the plant in Indiana provide electricity for an aluminum smelter and are co-located with a fourth unit that provides electricity to the grid and is a Table A unit.



<b>Table 2. Voluntarily Affected Units, 1995 &amp; 1996</b>		
	<b>1995</b>	<b>1996</b>
<b>TOTAL UNITS EACH YEAR</b>		
Affected units	182	168
Generating capacity (GW <sup>e</sup> )	41.6	37.2 <sup>a</sup>
1985-87 Baseline emissions (10 <sup>12</sup> Btu)	1,389	1,261 <sup>b</sup>
Actual emissions (10 <sup>3</sup> tons)	853	674
Allowances issued (10 <sup>3</sup> )	1,329	1,234
Allowances banked (10 <sup>3</sup> )	476	560
<b>EXITING/ENTERING UNITS<sup>c</sup></b>		
Affected units	32	11
Generating capacity (GW <sup>e</sup> )	9.1	4.7
1985–87 Baseline emissions (10 <sup>12</sup> Btu)	273	97
Actual emissions (10 <sup>3</sup> tons)	276	63
Allowances issued (10 <sup>3</sup> )	261	95
Allowances banked(10 <sup>3</sup> )	–15	32
<b>INDUSTRIAL OPT-IN UNITS</b>		
Number of units	0	7
Actual emissions (10 <sup>3</sup> tons)	NA	37
Allowances issued (10 <sup>3</sup> )	NA	49
Allowances banked (10 <sup>3</sup> )	NA	12
<b>UNITS AFFECTED BOTH YEARS</b>		
Affected units	150	150
Generating capacity (GW <sup>e</sup> )	32.5	32.5
1985–87 Baseline emissions (10 <sup>12</sup> Btu)	1,116	1,116
Actual emissions (10 <sup>3</sup> tons)	578	574
Allowances issued (10 <sup>3</sup> )	1,068	1,090
Allowances banked (10 <sup>3</sup> )	490	516

**Notes:** <sup>a</sup>Does not include industrial opt-in units.

<sup>b</sup>Baseline emissions for industrial opt-in units assumed equal to allowances.

<sup>c</sup>1995 and 1996 columns show data for units affected in those years only.

### ***C. Units Affected in Both 1995 and 1996***

The 150 continuing substitution and compensation units added to the 263 units listed in Table A yield 413 units "commonly affected" in both 1995 and 1996. These units account for the great bulk of allowances, emissions, banking and the reduction attributable to Title IV in both years. Accordingly, unless explicitly noted to the contrary, subsequent analysis is based on these units. The summary statistics for these 413 commonly affected units are presented in Table 3. In the main, the same conclusions hold for this smaller set as for the comparison made in Table 1: fewer allowances, more emissions, less banking, and a roughly constant reduction of emissions attributable to Title IV in 1996 compared to 1995. Table 3 clearly shows that most changes observed between 1995 and 1996 are due to the Table A units, which account for approximately 70% of the affected capacity and 85% of allowances and emissions. Both heat input and the average emission rate increased at Table A units in 1996, while the 150 continuing substitution and compensation units experienced little change in either.

The total number of Table A units retrofitted with scrubbers was brought to 27 by the addition of 6 more units that became operational in 1996. These units were Conemaugh 2, located in Pennsylvania, Petersburg 1 & 2 in Indiana, HMP&L Station Units 1 & 2 in Kentucky, and Niles 1 in Ohio. Emissions from these six units were 127,000 tons less than in 1995 and offset slightly over a third of the increase in emissions from the other Table A units. As was the case with the 21 units retrofitted with scrubbers in 1995, the utilization of these newly retrofitted units increased markedly, by more than 20% over the average for the preceding six years. The reasons for this marked shift of generation to newly retrofitted units is not entirely clear, but it has negated what might have been expected to be a tendency to shift generation away from the newly-constrained Phase I affected units to units that were not yet subject to Title IV limitations.

<b>Table 3. Data on Units Affected in Both 1995 and 1996</b>				
<b>Table A Units (263)</b>	<b>1995</b>	<b>1996</b>	<b>Change</b>	<b>% Change</b>
Heat input ( $10^{12}$ Btu)	4,708	4,897	+ 189	+ 4.0%
Emission rate (# SO <sub>2</sub> /mmBtu)	1.89	1.94	+ 0.05	+ 2.6%
Counterfactual emissions ( $10^3$ tons)	8,171	8,606	+ 435	+ 5.3%
Actual emissions ( $10^3$ tons)	4,445	4,759	+ 314	+ 7.1%
Allowances issued ( $10^3$ )	7,215	6,888	– 327	– 4.5%
Allowances banked ( $10^3$ )	2,770	2,129	– 641	– 23.1%
Title IV emission reduction ( $10^3$ tons)	3,726	3,847	+ 121	+ 3.2%
<b>Substitution/Compensation Units (150)</b>	<b>1995</b>	<b>1996</b>	<b>Change</b>	<b>% Change</b>
Heat input ( $10^{12}$ Btu)	1,377	1,366	– 11	– 0.8%
Emission rate (# SO <sub>2</sub> /mmBtu)	0.84	0.84	0	0
Counterfactual emissions ( $10^3$ tons)	762	751	– 11	– 1.4%
Actual emissions ( $10^3$ tons)	578	574	– 4	– 0.7%
Allowances issued ( $10^3$ )	1,068	1,090	+ 22	+ 2.1%
Allowances banked ( $10^3$ )	490	516	+ 26	+ 5.3%
Title IV emission reduction ( $10^3$ tons)	184	177	– 7	– 3.8%
<b>Total Units Affected Both Years (413)</b>	<b>1995</b>	<b>1996</b>	<b>Change</b>	<b>% Change</b>
Heat input ( $10^{12}$ Btu)	6,085	6,263	+ 178	+ 2.9%
Emission rate (# SO <sub>2</sub> /mmBtu)	1.65	1.70	+ 0.05	+ 3.0%
Counterfactual emissions ( $10^3$ tons)	8,933	9,357	+ 424	+ 4.7%
Actual emissions ( $10^3$ tons)	5,023	5,333	+ 310	+ 6.2%
Allowances issued ( $10^3$ )	8,283	7,978	– 305	– 3.7%
Allowances banked ( $10^3$ )	3,260	2,645	– 615	– 18.9%
Title IV emission reduction ( $10^3$ tons)	3,910	4,024	+ 114	+ 2.9%

### **III. ANALYSIS OF CHANGES OBSERVED IN 1996**

#### ***A. Changes in Emissions by Generating Units***

Emissions are the product of the heat input of fuel used at each generating unit and the SO<sub>2</sub> emission rate associated with the fuel, as modified by whatever sulfur-removal equipment may exist at the unit. Accordingly, changes in emissions from one year to another can be analyzed in terms of changes in heat input and in the emission rate. Since heat input for each unit is largely determined by the unit's position in dispatch and the overall demand for electricity, the variable over which an operator has most control for purposes of compliance with Title IV is emission rate. We therefore focus most of our unit-level analysis on changes in emission rates between 1995 and 1996.

The operators of most commonly affected units kept the 1996 emission rate very close to the 1995 rate; however, of those that did not, about twice as many increased the emission rate as reduced it. The top panel of Table 4 provides detail on the number of units, capacity, 1996 heat input, emissions, and allowances for the 413 commonly affected units, categorized according to whether their 1996 emission rate (1) increased more than 10%, (2) remained within  $\pm 10\%$ , or (3) decreased by more than 10% of the 1995 rate. Table 4 also shows, in the second panel, the decomposition of the change in emissions as a result of changes in heat input and emission rate. The 109 units whose emission rates increased significantly are almost entirely offset by the 68 units that decreased emissions significantly. As a result, the 310,000-ton aggregate increase in emissions in 1996 over 1995 can be almost entirely attributed to increased heat input, which is approximately evenly spread across units in the three categories.

Although the units' increasing and reducing emission rates almost completely offset each other, the question remains why nearly a quarter of the affected units would be increasing emission rates significantly. Furthermore, most of the offsetting reduction results from the implementation of decisions made prior to 1995-96. For instance, the six units that retrofitted scrubbers in 1996 account for 148,000 tons, or slightly less than half, of the 326,000 tons attributable to emission rate reductions at the 68 units.

**Table 4. Commonly Affected Units  
by Change in Emission Rate from 1995 to 1996**

	Decreasing	No Change	Increasing	Total
No. Of Units	68	236	109	413
Capacity (GW <sup>6</sup> )	18.67	64.46	37.36	120.49
1996 Heat input (10 <sup>12</sup> Btu)	1,024	3,457	1,783	6,264
1995 Heat input (10 <sup>12</sup> Btu)	999	3396	1690	6,085
1996 Emission rate (#/mmBtu)	1.22	1.90	1.60	1.70
1995 Emission rate (#/mmBtu)	1.82	1.85	1.16	1.65
1996 Emissions (10 <sup>3</sup> tons)	622	3,284	1,427	5,333
1995 Emissions (10 <sup>3</sup> tons)	909	3138	976	5,023
<b>ATTRIBUTION OF CHANGE IN EMISSIONS</b>				
Change in emissions	-287	+ 146	+ 451	+ 310
Due to heat input change	+ 39	+ 147	+ 107	+ 293
Due to emission rate change	-326	- 1	+ 344	+ 17

**Notes:** *Decreasing* is defined as a 1996 emission rate more than 10% below the 1995 rate. *No change* is an emission rate within +/-10% of the 1995 emission rate. *Increasing* is a 1996 emission rate greater than 10% above the 1995 emission rate.

Contracts for the construction of these scrubbers were almost certainly signed before 1995. Another 12 of these units, located in the area being heavily penetrated by PRB and western coals, account for an additional 78,000 tons, or another 20% of this total.<sup>3</sup> These switches would likely have occurred anyway, and their timing in 1996 may reflect expiration of pre-Phase I contracts that required the use of higher sulfur coals in 1995. When allowance is made for these units, only 50 units reduced emission rates for an aggregate reduction in emissions of about 100,000 tons. In contrast, 109 affected units increased emission rates by more than 10% and emissions by 344,000 tons. These actions increased the allowance costs incurred by the operator.

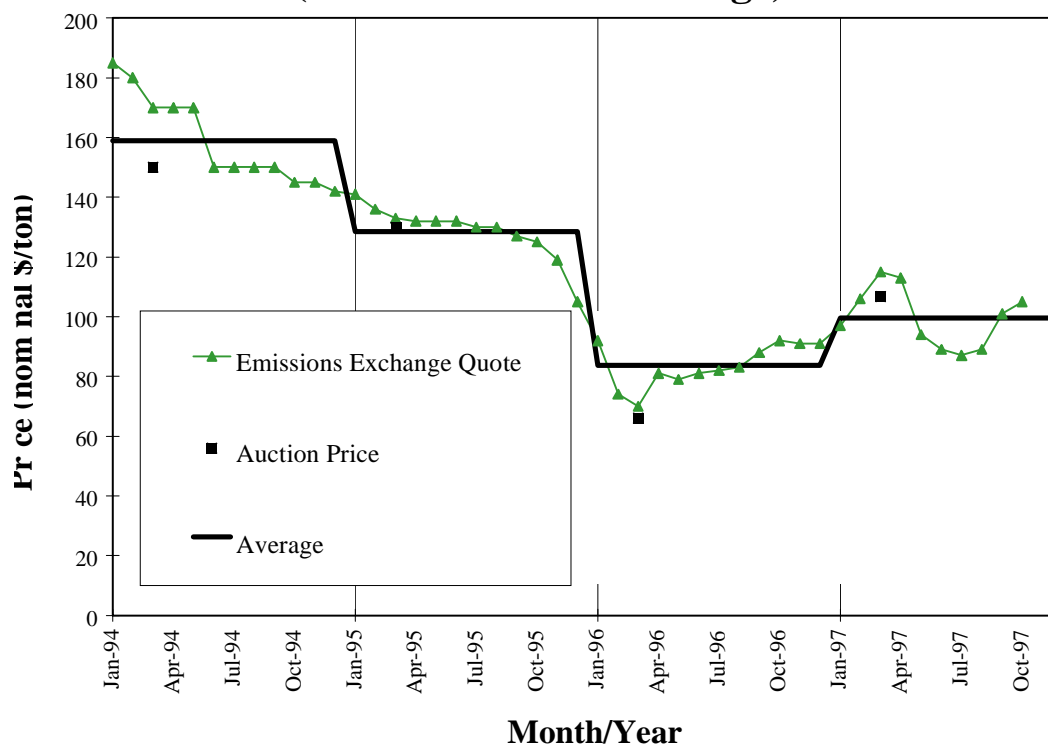
We turn now to the question of why some operators might increase allowance cost and use up allowances in 1996, rather than save them for Phase II when more stringent emission limits will be imposed.

<sup>3</sup> These 12 units are located in Iowa, Missouri, Illinois, and western Tennessee.

## B. The Price of Allowances

The most salient feature about the evolution of allowance prices to date is their steady decline from early 1994 to early 1996. In calendar year 1994, the average price of an allowance was \$159 and by 1995, the annual average price fell to an average of \$129. As Figure 1 shows, allowance prices fell precipitously in the latter half of 1995; by March 1996, the all-time low of \$70 was recorded.<sup>4</sup> Thereafter, prices rose steadily throughout 1996, but the average annual price for the year was \$84, well below the 1995 (not to mention the pre-Phase I) price.

**Figure 1: Allowance Prices, 1994-97  
(1995 or Current Vintage)**



<sup>4</sup> This is the Emissions Exchange quote for March 1996. The EPA auction that same month cleared at a price of \$66.05.

The price of an allowance indicates to all operators the value of an additional ton of emission reduction. Operators of affected units who are attentive to the market price of allowances will compare this value to the incremental cost of burning a lower-sulfur coal. When the difference between the prices of lower- and higher-sulfur coals is greater than what is justified by the current price of allowances, such operators will save money by purchasing the higher-sulfur coal and using more allowances.

Unfortunately, there is no good indicator of coal-sulfur premiums applicable in all locations and to which movements in allowance prices can be compared. This is because the coals competing at most powerplants typically come from different locations, so the difference in price between coals of varying sulfur content is as much an issue of transportation and mine cost as it is the sulfur premium that might be defined in some single mining district, such as Central Appalachia. Nevertheless, it is likely that the higher allowance prices in 1994 and 1995, not to mention expectations that allowance prices would rise with the start of Phase I, caused operators to contract for lower-sulfur coals in 1994 and 1995. Depending on the length of the contract, those purchases would be delivered over periods ranging from three months to several years, and at least some of those contracts would be expiring in 1996. With lower allowance prices and the same coal-sulfur premium, some operators would be able to reduce generating cost by shifting back to higher-sulfur coals. More would be spent, or foregone, on allowances, but the extra expense would be more than compensated by the reduced fuel cost.

The higher-sulfur coals purchased by operators of the 109 units increasing emission rates in 1996 were not necessarily what would be considered “high-sulfur” coals, as shown by Table 5. Whether judged by percentage or absolute change, most units whose emission rates increased in 1996 switched from low- to mid-sulfur coal, or increased rates within the mid-sulfur ranges. Only about 15 of the units switched either from mid-sulfur to high-sulfur ranges or to even higher-sulfur coals within the high-sulfur ranges. This shift to slightly higher sulfur content among the low- and mid-sulfur coals indicates that higher sulfur content is penalized across the entire sulfur range of coal, not just for some high-sulfur coals, and that at least some operators of affected units are arbitraging between allowance and coal markets.

**Table 5. Coal Switching by Units That Increased  
Emission Rate from 1995 to 1996**

		1996 Emission Rate (lbs/mmBtu)					TOTAL
		< 1.5	1.5–2.5	2.5–3.5	3.5–5.0	> 5.0	
<b>1995 Emission rate (lbs/mmBtu)</b>	< 1.5	48/4	17/9	1/1			66/14
	1.5–2.5		15/5	13/13			28/18
	2.5–3.5			1/0	5/5		6/5
	3.5–5.0				3/3	5/5	8/8
	> 5.0					1/1	1/1
	<b>TOTAL</b>	48/4	32/14	15/14	8/8	6/6	109/46

**Notes:** • The categorization of units used here reflects roughly what would be considered to be low-, low-to-mid, mid-to-high, high-, and very-high-sulfur coal.  
• The number preceding the slash mark in each cell entry indicates the number of units that increased the emission rate by more than 10%, corresponding to the categories used in Table 4. Since many of these units are in the low-sulfur categories and a 10% increase could be small, the number that increased the emission rate by more than 0.40#/mmBtu is indicated after the slash mark.

### ***C. Emissions Trading at the Unit and Utility Level***

As in 1995, utilities made significant use of emissions trading to avoid high-cost abatement at some units currently and in the future through banking. Table 6 presents the data on all affected units that were bankers and acquirers of allowances in 1995 and 1996.<sup>5</sup> The number of units banking declined, as did the total allowances banked and the average number of allowances banked per unit, while the number of units acquiring allowances from other units to cover emissions in excess of unit allowance allocations increased, as did the total number of such allowances and the average number of allowances purchased per unit. The reduction in banking and increased use of allowances to cover "excess" emissions is particularly noticeable among the 413 commonly affected units. As shown in Table 7, 25 of these units shifted from being bankers in 1995 to acquirers of allowances in 1996. At the utility level, as shown by Table 8, a similar small change was observed in the number of independent utilities and holding companies with affected units that were net bankers and acquirers of allowances.

<sup>5</sup> We adopt the term *acquirers* to denote those who acquire allowances from other units or the accumulated bank to cover emissions in excess of the allowances allocated to their unit in 1996.



<b>Table 6. Net Banking Positions in 1995 &amp; 1996</b>			
	<b>1995</b>	<b>1996</b>	<b>Difference</b>
Total affected units	445	431	-14
Total net banking (10 <sup>3</sup> )	3,246	2,688	-558
Number of units banking	346	318	-28
Allowances banked (10 <sup>3</sup> )	3,780	3,377	-403
Average per unit	10,949	10,619	-330
Number of units acquiring	98	109	+11
Allowances acquired (10 <sup>3</sup> )	534	689	+155
Average per unit	5,449	6,321	+872
Zero banking units <sup>1</sup>	1	4	+3

**Note:** <sup>1</sup> These units (substitution units, Wood River 1 in both years, and Poston 1, 2, and 3 in 1996) neither received allowances nor had any emissions in the respective years.

<b>Table 7. Change of Banking Status by Units, 1995 to 1996</b>				
	<b>Bankers</b>	<b>Acquirers</b>	<b>Zero</b>	<b>Total</b>
1995 Status	346	98	1	445
Commonly affected units	-28	+25	+3	0
Units exiting in 1996	-16	-16	0	-32
Units entering in 1996	+16	+2	0	+18
1996 Status	318	109	4	431

<b>Table 8. Banking Status by Utility</b>		
	<b>1995</b>	<b>1996</b>
Utilities with affected units	57	56
Net acquirers of allowances	6	7
Net bankers of allowances	51	49
Trading among units	21	20
No trading among units	23	21
Single affected unit	7	8

Table 9 provides more detail on the nine utilities for which emissions from affected units were higher in the aggregate than the number of allowances issued to those units in 1995 and/or 1996. Four of the six utilities having this status in 1995 remained so in 1996, while two became net bankers (one, Indianapolis Power & Light, because of the retrofitting of two units with scrubbers). Three other utilities changed from being net bankers in 1995 to net acquirers in 1996. In contrast to the four utilities that were net acquirers in both 1995 and 1996, which could only have obtained the necessary allowances from other utilities, the three utilities that became net acquirers in 1996 would have been able to draw from the amounts they banked in 1995.

Most of the change in the net banking position of units and utilities occurred in 19 of the 56 utilities that had affected units during both years. Table 10 decomposes the net change in banking position for all 413 units affected in both years, and attributes the change to changes in emission rates, heat input, and allowance allocation.<sup>6</sup> Of the 56 utilities and 413 units, 37 utilities and 144 units experienced little change in any of these variables. The remaining 19 utilities and 269 units account for virtually all of the 600,000-allowance decrease in banking in 1996. About half of the total reduction in banking was due to increased emissions; the other half was due to reduced allowance allocations. The 19 utilities are further subdivided into four categories, according to the factor most responsible for their change in banking status. The only group to experience a net increase in banking included three utilities that retrofitted scrubbers in 1996. Two other utilities increased banking because of increased allowance allocations, but for the remaining 14 utilities, higher heat input, higher emission rates, and fewer allowances led to significantly less banking in 1996 than in 1995.

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<sup>6</sup> The decomposition into the constituent elements is accomplished by the following discrete approximation:

$$dNTP = \bar{r} dH + \bar{H} dr - dA$$

where  $dNTP$  is the observed annual difference in net trading position,  $dH$  is the observed annual difference in heat input,  $dr$  is the observed annual difference in emission rate,  $dA$  is the observed annual difference in allowance allocation,  $\bar{r}$  is the simple average of the unit emission rates during the two years, and  $\bar{H}$  is the simple average of the unit heat input during the two years.

**Table 9: Utilities Engaging in Inter-Utility Trading in 1995 or 1996**

All Affected Units	Aggregate Utility Undercompliance				Total Allowances		% Under/OverComp	
	1995	1996 Abs Chg	Sum2Yrs		1995	1996	1995	1996
<b>Total Interutility</b>	147,770	168,617	20,847	316,387	459,082	675,589	32%	25%
<b>1995 Utilities</b>								
Illinois Power	110,925	127,480	16,555	238,405	186,579	194,573	59%	66%
Indianapolis P&L	24,022	(24,837)	(48,859)	(815)	126,881	96,655	19%	(26%)
Duquesne Lighting	4,720	1,841	(2,879)	6,561		38,139	12%	5%
					38,139			
Tampa Electric	4,647	9,414	4,767	14,061		86,485	5%	11%
					86,485			
Hoosier Energy REC	2,215	(5,077)	(7,292)	(2,862)		18,427	12%	(28%)
					18,427			
Iowa PubSvc Co	1,241	1,211	(30)	2,452		2,571	48%	47%
					2,571			
<b>TOTAL 1995</b>	147,770	110,032	(37,738)	257,802	459,082	436,850	32%	25%
<b>New 1996 Utilities</b>								
Baltimore G&E	(9,317)	7,265	16,582	(2,052)		21,479	(43%)	34%
					21,479			
Centerior Energy Corp	(25,359)	10,672	36,031	(14,687)	213,788	211,188	(12%)	5%
Cent III PubSvc Co	(25,932)	10,734	36,666	(15,198)	121,154	121,154	(21%)	9%
<b>TOTAL 1996</b>	(60,608)	28,671	89,279	(31,937)	356,421	353,821	(17%)	8%

**TABLE 10: CHANGE IN NET BANKING POSITION BY UTILITY**

413 Unit Universe	Units	Net Banking Position			Change Due to...			Percent		
		1995	1996	Change	Heat Input	Emis Rate	Allow Alloc	Heat	Rate	Allow
<b>All Utilities</b>	<b>413</b>	<b>3,260,154</b>	<b>2,644,778</b>	<b>(615,376)</b>	<b>(293,294)</b>	<b>(16,904)</b>	<b>(305,178)</b>	<b>48%</b>	<b>3%</b>	<b>(50%)</b>
37 Utilities with Little Change	144	1,113,137	1,096,371	(16,766)	(2,979)	(10,885)	(2,902)	18%	65%	(17%)
19 Utilities w/Big Changes	269	2,147,017	1,548,407	(598,610)	(290,315)	(6,019)	(302,276)	48%	1%	(50%)
<b>Due to Emission Rate</b>	<b>87</b>	<b>707,577</b>	<b>386,326</b>	<b>(321,251)</b>	<b>(87,711)</b>	<b>(209,266)</b>	<b>(24,274)</b>	<b>27%</b>	<b>65%</b>	<b>(8%)</b>
AEP	35	455,088	256,214	(198,874)	(63,374)	(123,519)	(11,981)	32%	62%	(6%)
Baltimore G&E	2	9,317	(7,265)	(16,582)	(3,027)	(13,555)	0	18%	82%	0%
So Indiana G&E	3	12,652	(7,546)	(20,198)	(1,665)	(18,533)	0	8%	92%	0%
Springfield, City of (Mo)	4	13,366	463	(12,903)	(1,784)	(11,119)	0	14%	86%	0%
Cinergy	22	91,216	45,317	(45,899)	(3,690)	(29,926)	(12,283)	8%	65%	(27%)
Ohio Edison	21	125,938	99,143	(26,795)	(14,171)	(12,614)	(10)	53%	47%	(0%)
<b>3 Utilities w/96 Scrubbers</b>	<b>22</b>	<b>116,187</b>	<b>233,315</b>	<b>117,128</b>	<b>(26,746)</b>	<b>144,507</b>	<b>(633)</b>	<b>(23%)</b>	<b>123%</b>	<b>1%</b>
Big Rivers Electric	7	28,951	39,859	10,908	(5,287)	15,612	583	(48%)	143%	(5%)
GPUC	8	98,031	168,619	70,588	(5,637)	77,441	(1,216)	(8%)	110%	2%
Indianapolis P&L	7	(10,795)	24,837	35,632	(15,822)	51,454	0	(44%)	144%	0%
<b>Due to Higher Heat Input</b>	<b>138</b>	<b>926,393</b>	<b>781,739</b>	<b>(144,654)</b>	<b>(168,527)</b>	<b>26,890</b>	<b>(3,017)</b>	<b>117%</b>	<b>(19%)</b>	<b>(2%)</b>
Centerior Elec Corp	25	25,359	(10,672)	(36,031)	(31,432)	(1,999)	(2,600)	87%	6%	(7%)
Cent III PS Co	15	25,932	(10,734)	(36,666)	(33,631)	(3,035)	0	92%	8%	0%
Consumers Power	4	31,630	20,103	(11,527)	(11,247)	(281)	0	98%	2%	0%
Southern Company	48	544,793	514,363	(30,430)	(27,805)	(2,208)	(417)	91%	7%	(1%)
Illinois Power	15	(111,627)	(129,698)	(18,071)	(24,901)	6,830	0	138%	(38%)	0%
Kentucky Utilities	5	86,959	77,235	(9,724)	(12,088)	2,364	0	124%	(24%)	0%
TVA	26	323,347	321,142	(2,205)	(27,423)	25,219	0	1244%	(1144%)	0%
<b>Due to Allowance Changes</b>	<b>22</b>	<b>396,860</b>	<b>147,027</b>	<b>(249,833)</b>	<b>(7,331)</b>	<b>31,850</b>	<b>(274,352)</b>	<b>3%</b>	<b>(13%)</b>	<b>(110%)</b>
PacificCorp	4	18,179	50,200	32,021	1,285	(160)	30,896	4%	(0%)	(96%)
Potomac Electric	6	33,062	40,047	6,985	(3,335)	1,320	9,000	(48%)	19%	(129%)
Union Electric	12	345,619	56,780	(288,839)	(5,281)	30,690	(314,248)	2%	(11%)	(109%)

## IV. CONCLUDING OBSERVATIONS

There are two ways to view compliance with Title IV in 1996 as compared with 1995. From one point of view, 1996 was very similar to 1995. There were small changes in coverage, emissions, and allowances, but the important aspects remained unchanged: a significant reduction of emissions below what would otherwise be the case, mainly from Table A units, and significant banking of allowances.

From another point of view, 1996 can be seen as unusual in that the average emission rate of affected units might have been expected to decline as Phase II approached. The unexpected increase in average emission rates is, however, the mirror image of the equally unexpected fall in the price of allowances between 1994 and 1995. With lower allowance prices, it is cheaper in at least some locations to spend more on allowances in order to take advantage of lower-priced, higher-sulfur coal.

The more fundamental issue is why allowance prices fell so precipitously in late 1995 and early 1996. As explained more fully in our more comprehensive analysis of compliance in 1995, the cause was a combination of the recognition that current and future costs would be lower than expected and the very low variable cost of abatement by scrubbers, which established the floor. For a variety of reasons, Phase I has been characterized by overinvestment in compliance, and the response is a lower allowance price trajectory, as well as a deferral of the time when higher-cost, Phase II abatement will be required. As such, the increase in emission rates in 1996 is a transitory phenomenon that reflects an adjustment to the overinvestment in compliance that has characterized Phase I, rather than movement along an equilibrium path.

Since early 1996, allowance prices have been on an upward trend. In part, this reflects the greater demand for allowances that appeared as utilities shifted to higher-sulfur coals, but it is also more like the movement along the longterm trajectory that can be expected to characterize allowance prices as Phase II approaches. In this light, 1996 can be seen as a year of adjustment and of transition to a more realistic view of current and future abatement costs.

## REFERENCES

Atkeson, Erica (1997), "Joint Implementation: Lessons from Title IV's Voluntary Compliance Programs," Working Paper 97-003, MIT Center for Energy and Environmental Policy Research (CEEPR), May.

Ellerman, A. Denny, Richard Schmalensee, Paul L. Joskow, Juan Pablo Montero, and Elizabeth M. Bailey (1997), *Emissions Trading under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance*, Special Report, MIT Center for Energy and Environmental Policy Research (CEEPR), October.

Montero, J.P. (1997), "Volunteering for Market-based Environmental Regulation: The Substitution Provisions of the SO<sub>2</sub> Emissions Trading Program," Working Paper 97-001, MIT Center for Energy and Environmental Policy Research (CEEPR), January.